Process engineering for microalgal biorefineries
environmental and economic assessments

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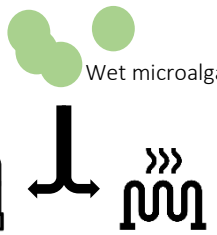
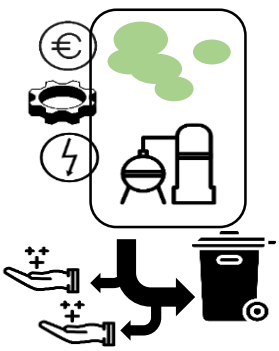
INTRODUCTION

- Depending of the purpose, microalgae biomass is processed into valuable compounds (through biorefinery) or dried to powder
  - The feasibility of microalgal biorefineries is limited to the production of few added value products, mainly due to the energy costs of the downstream processes
  - Dried microalgae are mostly produced for human nutrition purposes (dietary supplements)
- Microalgal biorefineries feasibility relies mostly on the economical aspects (market values of the products), while the environmental aspects are less considered.
- The economic feasibility and environmental sustainability of microalgal biorefineries including a cascade of processes to valorise multiple products are worth to be investigated.



Biorefinery
Value added products
Human nutrition, animal feed, cosmetics, pharmaceuticals, energy

Drying
Dried biomass
Human nutrition, animal feed, energy

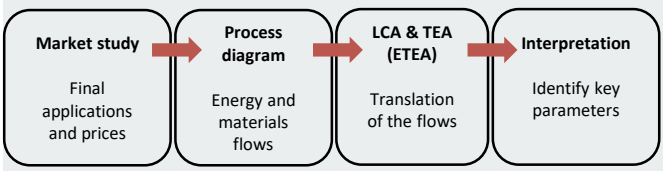


OBJECTIVES

- Identify and evaluate plausible scenarios of microalgal biorefinery pathways using *Chlorella vulgaris* biomass
  - Multiple products extraction: cascade processes
  - Economic and environmental perspective

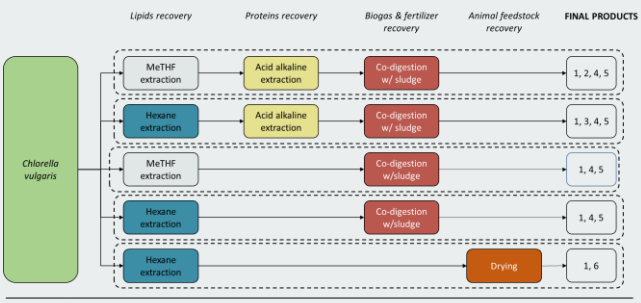
METHODS

- Literature review and experts consultation
  1. Identify the value added products from *C. vulgaris*
  2. Verify the feasibility of multiple target products extraction in cascade processes
  3. Model the inputs – outputs flows of the processes
- Assessment of the microalgal biorefinery scenarios
  1. Environmental sustainability: Life Cycle Assessment (LCA)
  2. Economic feasibility: Techno-Economical Assessment (TEA)
- Interpretation
  1. Sensitivity / what-if analysis
  2. Uncertainty analysis on the key parameters



ETEA methodology adapted from Thomassen et al. 2017

SCENARIOS



FINAL PRODUCTS
(1) Lipids for chemical feedstock; (2) Proteins for cosmetic feedstock; (3) Proteins for human food additives; (4) Biogas for energy; (5) Crop fertilizer; (6) Animal feedstock

- Target: production of lipids for chemical feedstock
- 5 scenarios are identified according to:
  - extraction of both lipids (2 solvents are tested) and proteins, valorisation of the remaining biomass by co-digestion
  - only lipids extraction (2 solvents are tested) and valorisation of the remaining biomass by co-digestion or drying.

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